FRACTURE STRENGTH OF MULTI-WALL CARBON NANOTUBES

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Abstract

Arc-grown multi-wall carbon nanotubes (MWCNTs) were studied with tensile loading experiments inside an scanning electron microscope (SEM) with a home-built nanomanipulator[1]. Individual MWCNT was clamped between two opposing AFM cantilever tips, and a newly developed and rapid electron beam induced deposition method[2] was used to make the clamps. An increasing tensile load was applied to the nanotube through cantilever deflection induced by the controllable bending of the piezo multi-layer bender with a DC bias. High-resolution SEM images were acquired at each loading step. Two independent methods of analysis of each image were used to obtain the corresponding tensile load. The MWCNTs eventually fractured with increasing tensile load, typically in a sword-in-sheath manner (Figure 1). The MWCNT diameters were measured by TEM after the tests (Figure 2). The stress *vs* strain, Young's modulus, and tensile strength of the MWCNTs were obtained through data analysis.

The measurements strongly suggest the presence of defects in the tested nanotubes. Assuming defects like clusters of adjacent vacancies (e.g., atomistic blunt cracks) the experimental evidence is rationalized by applying Quantized Fracture Mechanics[3].

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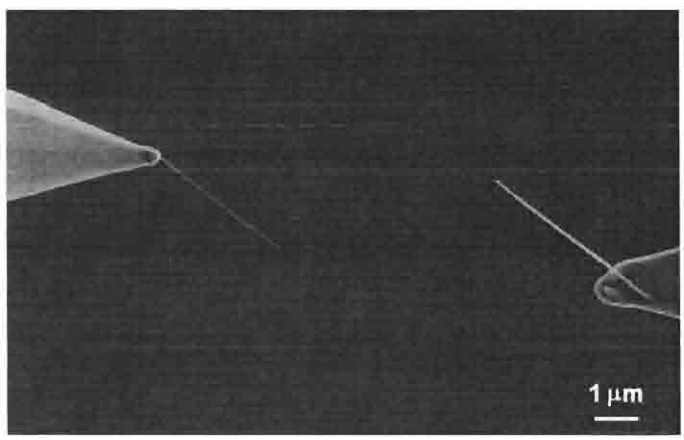

Figure 1. Sword-in-sheath failure of a MWCNT under tensile load

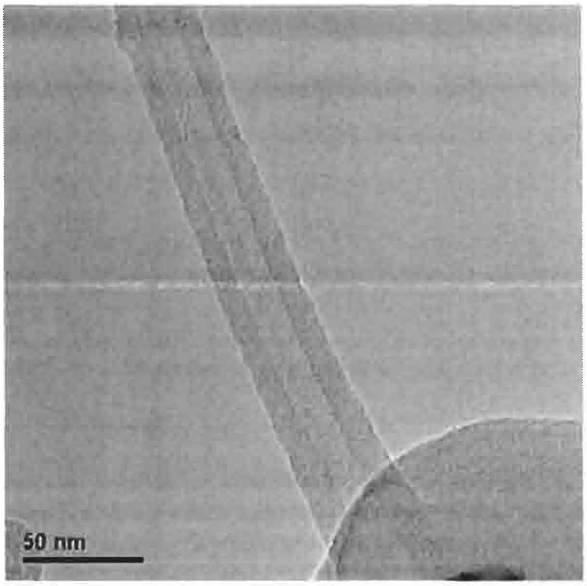

Figure 2. TEM image of a fractured MWCNTs attached to AFM tip.

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